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Democracy Dies in Darkness

Think California's current drought is bad? Past incarnations have lasted hundreds of years

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California is now five years deep into one of its most severe droughts on record, and scientists are continually probing the different factors that affect the state's climate, and how much those are related to the overall warming of the globe. Increasingly, this means looking back into the past for clues about how the region has changed over the last few thousand years and what influences might shape its future.

In this connection, new research published Thursday in the journal Scientific Reports suggests the Pacific Ocean may play a bigger role than anyone thought — and an unexpected one. Moreover, it suggests that massive long-term droughts can hit the region in conjunction with cycles of ocean warming and cooling — and that if these patterns continue to hold, another megadrought could lie in the future.

"What this paper provides is a new analysis of the link between what happens in the ocean and what happens in terms of the water availability on the land," said Noah Diffenbaugh, a climate system expert at Stanford University, who was not involved with the new study.

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The researchers looked back into California's history by examining sediment samples from a body of water known as Kirman Lake, located in the central-eastern part of the state. Chemical analyses of sediment samples can give scientists all kinds of information about a region's climate history, including how its temperature and precipitation have changed over thousands of years. The researchers then compared these analyses with temperature reconstructions built from Pacific marine sediment records.

The researchers found that California experienced a dry period starting around 8,000 years ago and lasting for the next 5,000 years. This period was marked by certain chemical signatures in the lake sediments, as well as the disappearance of mollusks and the increase of certain other types of plants and microorganisms better suited to the kinds of saltier, marshier conditions characteristic of a more arid environment.

During this same period of time, the Pacific Ocean reconstructions suggest that ocean temperatures in the tropical eastern part of the Pacific cooled down, while they rose in the west. The researchers noted these conditions would have been similar to a La Niña event — one lasting several thousand years. A La Niña event is characterized by unusually cool ocean temperatures in the eastern Pacific around the equator, which can cause climate disturbances all over the world.

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In the midst of this long arid period, there was one major shift around 4,200 years ago, marked by cooler, moister conditions in California. This event was accompanied by a reversal in the Pacific conditions observed before, with the eastern Pacific warming back up and the western Pacific cooling down, a pattern more consistent with a very long-term version of an El Niño event.

The same thing happened starting around 3,000 years ago when the long dry period ended, and the environment in California has generally been wetter ever since. However, this period of time has been punctuated by occasional dry periods, often lasting for hundreds of years at a time. One of these dry periods corresponds with a global climatic shift known as the Medieval Climate Anomaly, a relatively warm period that was also accompanied by shifts in Pacific Ocean sea surface temperatures back towards something resembling a long-term La Niña.

The point is that changes in the Pacific Ocean appear to be closely linked to past shifts between drier and wetter conditions in California. This is possible because events in the ocean and the atmosphere tend to be so closely linked. For example, a standard La Niña event can cause changes in precipitation and weather patterns around the world, forcing a northward shift in the jetstream and leading to colder, rainier conditions in the Pacific northwest and an increased likelihood of drought further south.

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La Niña events are just temporary oscillations though, typically only lasting about a year. In contrast, the past Pacific Ocean shifts noted by the researchers in this study were likely linked to natural changes in sunlight falling on the Earth caused by subtle long-term shifts in the planet's orbit, as well as volcanic activity affecting how much heat the earth receives. These events led to temporary climate warming that induced La Niña-like conditions in the Pacific.

Increased amounts of solar energy reaching the Earth "appears to have had catastrophic effects in extending droughts," said Glen MacDonald, a drought and climate science expert at the University of California Los Angeles and lead author of the study, in a statement. "When you have arid periods that persist for 60 years, as we did in the 12th century, or for millennia, as we did from 6,000 to 1,000 B.C., that's not really a 'drought.' That aridity is the new normal."

The big question on researchers' minds now is whether human influences — namely, our greenhouse gas emissions rising in the atmosphere could elicit the same kinds of responses from the Pacific Ocean that these past changes in the planet's orbit caused.

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While greenhouse gas emissions are causing the planet to warm, the way they're physically doing so is unlike any of the natural variations the planet has seen in the past. So scientists can't say for sure that the ocean will respond the same way it has in the past. Indeed, some researchers think global warming will shift us into more of an El Niño-like world, rather than a La Nina-infused one. A 2015 study in Nature Climate Change, for instance, suggests that greenhouse warming could contribute to an rise in extreme El Niño events, although the paper also notes that the frequency of extreme La Nina events could also increase in response.

But if the patterns of the past do repeat — and that's a big if — the region has the potential to experience some of the same prolonged dry periods that it's seen in the past. This could mean droughts lasting hundreds of years. But for now, the idea remains characterized by major uncertainty — and Diffenbaugh, the Stanford researcher, noted there's no reason to believe the current drought will last that long.

"The jury is still out on this question, with some climate models calling for a rainier future in California and others calling for a drier future," added Park Williams, an expert in climatology and ecology at Columbia University (who was not involved with the new study), in an emailed comment to The Washington Post.

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In fact, Williams added, research suggests the current drought is "almost certain to end in the next few years."

Still, looking into the past can provide scientists with important insights into the possibilities that exist for the future and what we need to do to better understand them.

"As the authors very wisely point out, increased sunlight is not the same thing as increased greenhouse gases," Williams noted, "but it is nonetheless very important to understand that California's climate is very sensitive to the Earth's energy balance and that the hydrological shifts can last for far longer timescales than California's population is accustomed to."

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